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Author(s): B. H. P. Rivett

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A Survey of Operational Research in British Industry*

B. H. P. RIVETT

National Coal Board

This paper surveys the recent development and present position of operational research in British industry. It makes a critical examination of the relationship between the techniques available and the types of problem on which they are deployed; it surveys the type of people now carrying out operational research and comments on career opportunities. The paper also considers the integration of operational research within industrial organizations and suggests ways in which it can be related to other management services.

1. Introduction

THE task of this paper is to outline the current development in industrial operational research, to sketch our strong points and to indicate the areas in which the subject is weak. It is hoped that this will supplement earlier papers by Goodeve and Ridley¹ and Gander².

It will be wise at the beginning of the paper to make two important reservations. In the first place the paper has to be subjective in character. It is possible to find out something of the problems on which our people are currently engaged. The extent to which it is possible to classify these problems is open to debate and in any event the classification itself is subject to the present fancy of the particular scientist concerned. The second reservation stems from the first and is that the views expressed herein are those of the writer and do not necessarily represent the official opinion of the Operational Research Society.

Two approaches have been followed to get the basic information for this survey. The first was a survey of a random sample of the membership (full and associate) of the Operational Research Society. One hundred questionnaires were distributed of which seventy-six were returned. The

* Paper presented at the Annual Conference of the Operational Research Society at Harrogate on 10 June, 1959.

second was to obtain from a number of senior operational research workers, answers to specific questions; this gave information on a further 180 workers.

It is well to remember in surveying operational research that, so far as other sciences are concerned, it is still quite young. Although no one would claim that no operational research had been done prior to the coining of the phrase in 1936, it is only in the last 20 years or so that the subject has been widely studied and developed. It should not be expected therefore that the subject should stand at present as a coherent whole and that the techniques of the subject should be applicable to all industrial subjects. Operational research is still in the stage of fast development and, in common with any other science, will only continue to develop as long as it is being posed problems which at the moment of their posing are unsolvable.

The development of any science is conditioned primarily by the interaction of the scientists concerned and of the subject matter. This paper will therefore begin with a short survey of the people who are currently doing operational research, their background, their education and their salaries. The following sections will then consider the types of work on which these people are engaged and the techniques being used. The concluding sections will deal with the organization of the operational research groups and the consideration of how effective operational research groups have been.

2. Operational Research Workers

In this section data will be given regarding the age, experience and qualifications of operational research workers. Apart from one or two special cases no information will be presented to give similar data for scientists generally; this is simply because of the difficulty of obtaining such data.

The first point to note is the comparative youth of the scientists in our groups. The average age is 29, but many are in their early twenties. The average experience in operational research is 4 years. The average time that people have been in their present jobs is 3 years, but 75 per cent have been in their present jobs less than 3 years; this does not necessarily reflect high turnover of staff, since the operational research field has expanded greatly in the past 10 years.

The essential feature of operational research is that it is *research*, and operational research workers should as research workers rank in the

front line. Although it is dangerous to place too much emphasis on first degree qualifications, it is disappointing that of the people surveyed only 12 per cent had first class honours. In addition, only 12 per cent had done post-graduate research leading to a degree. There is a predominance of mathematicians and statisticians in our operational research groups, but it is particularly interesting to note the wide range of subjects in which operational research workers have specialized, including meteorology, astronomy and logic. Some senior operational research workers are disturbed at the high proportion of mathematicians and statisticians in operational research. During these early stages of the subject, however, the degree speciality of a person may not matter much, so long as he eventually becomes an operational research scientist. A large number of people surveyed had gone to full-time operational research courses, mostly of the two-week variety. Two operational research groups had so far put on their own internal course in operational research to train their recruits; these were the groups at the United Steel Companies and at the National Coal Board.

At present the literature on operational research is not overwhelming in its extent. Most people seem to have read some or all of Churchman, Ackoff and Arnoff, and some or all of the *Operational Research Quarterly*. The American journals, *Operations Research* and *Management Science*, were also read extensively. Operational research workers do not seem to spend much of their own money in buying books on their subject, although this may be a common trait of scientists generally.

The overlapping of other scientific societies was not as great as might have been expected. The only society with which the Operational Research Society has a significant common membership is the Royal Statistical Society, to which one-third of the people surveyed belonged.

About half the people who were approached wanted to stay in operational research until they retire. Of those who wished to leave the subject the majority wanted to go into some form of administration or management (some comments on the extent to which this desire is likely to be satisfied are given in Section 7).

Most people felt they are paid roughly the same as similar specialists in their firm who are not doing operational research. The following table is based on a general impression gained in discussing salaries with senior operational research workers and gives an average salary for a competent operational research worker or a competent scientist recruit to operational research.

It is interesting to compare these figures with a survey carried out recently amongst the Fellows of the Royal Statistical Society.

TABLE 1

Experience in Operational Research (years)	Age (years)		
	20	25	30
	Salary		
	£	£	£
0	700	900	1,200
5	x	1,100	1,650
10	x	x	1,900

TABLE 2

Age	Median Salary
	£
25-29	870
30-39	1,274
40-49	1,805
50-59	over 2,000
60-69	over 2,000

The operational research salaries provide a stimulating incentive to the young graduate coming fresh into the subject, but it is open to question how far these men can be retained into their years of maturity (see Section 7).

3. The Type of Work Now Being Tackled

Current operational research literature shows a basic pattern of work in which the dominant note is mathematics or statistics. The main emphasis in published work is on the manipulation of models and the derivation of hypotheses. It is rare indeed to see the verification of the model attempted and to this extent the subject, *in so far as the published papers are concerned*, is not a science but sophisticated crystal-gazing. Industrial operational research workers know that the literature does not reflect the activity, but it is not surprising that some scientists outside operational research look on the subject as a branch of applied mathematics or statistics. It is however a pity, indeed it is a serious criticism, that the *Operational Research Quarterly* is not bulging with completed case studies which are the subject of comment and criticism. A scientific journal

is the first line of communication among scientists and until a new scientific work is exposed in the literature it cannot be regarded as a serious contribution to the subject. Operational research workers generally share a responsibility for the quality and quantity of papers appearing in their journal.

The task of an industry can be divided very broadly under the following headings:

Purchasing	Finance
Stock holding	Personnel
Production	Marketing
Research and Development	

The ultimate stage in the development of operational research in industry will be achieved when operational research work is carried out at a level above all these separate areas, which will involve studying the general strategy of an industry and resolving the conflicts which are inherent and inevitable in the compartmentalization. Some operational research groups are carrying out studies in this strategic field, but so far not very much effort has been deployed here. Before moving into this field it is necessary to carry out basic studies in the separate parts of an organization; sub-optimization must precede optimization. A second reason for not much work being done in this strategic field is that there is a shortage of mature, able operational research workers who can move at will within an industry without giving offence, who have the intrinsic scientific ability to carry out strategic studies and who also have the personality to encourage a board of directors to repose this confidence in them. Many operational research workers are frustrated in that they are not yet working in this strategic area. They feel like a doctor who is restricted to examining the patient's feet, while all the time his real trouble is somewhere else. It would be wise, however, not to underestimate the effect of the shortage of mature operational research workers and anyone who has been asked to advise a firm on their first operational research appointment meets two difficulties:

- (a) to persuade the firm to appoint a first-rate man and not simply an operational research technician, and
- (b) to find such a man.

Within the component parts of the organization, which is where most operational research groups work at present, the field of activity is still unbalanced. Little work is being done in the area of personnel management—human relations, absenteeism, accidents, morale, incentives,

selection and training of staff and so on. The obvious difficulty here is that of getting the means of measurement; until the scientist can measure, he is impotent. In this particular area we largely depend on the social scientist to produce the measures. The importance of human factors on the economy of the firm should not be underestimated and more social scientists should be recruited to operational research groups, provided they are real scientists specializing in the human problems area.

Another area in which little activity is in progress is that of purchasing. The nature of purchasing, with the twin requirements of market forecasting and of competition with other purchasers, would seem to make the field a fertile one for the scientific approach. One inhibiting factor would probably be the speed with which results are required; this point was well brought out by Crack in a paper at the 1958 Harrogate Conference.⁴

The third field in which not much work is currently in hand is that of marketing. Market research has, of course, been widely developed in recent years, but so far there has been little liaison between market research and operational research. There is an obvious link between market research and the social scientist in the field of motivation research. It would be interesting to see how far these new techniques can produce methods of measurement which can be used by the operational research workers. As a particular part of the marketing field there is advertising, in which the mystique of the craft has so far almost completely excluded the scientist. To derive and confirm models for consumer response to advertising is extremely difficult; this should, however, be a valuable area for operational research in view of the amount of money being spent by industry on advertising. Allied with this is the problem of fixing the selling price of a commodity; the derivation of the true cost of producing a particular line and hence the optimum selling price is an obviously important topic on which much work remains to be done.

What then are the main problem areas in which operational research work is currently being carried out? As might be expected the main fields are finance, inventory, production and transportation. In finance the main effort is in some form of cost accountancy and cost control; the important aspect of financial control is not receiving the attention it deserves. The difficulty of getting from the cost accountants basic data which operational research workers feel are "true" is one of the inhibiting factors here. The cost accountant is in a key position in industry since it is he who produces the basic cost information.

The operational research worker and the cost accountant must work together and more effort should be deployed by both sides in getting to know the other's speciality.

Inventory control is currently the subject of much activity and the following section will comment on the adequacy of the theory of inventory control. Operational research workers, however, have done a great deal of useful work in this area. In a similar way transportation studies have been tackled quite widely. Unlike inventory control, the techniques seem well adapted to the real life problem.

The manifold, interlocking and competing demands in production make this a fertile field for useful operational research activity. The operational research specialist has been accepted here and this is probably the most common area of work.

4. Techniques of Operational Research

In any operational research project the first stage is to set out the objectives which have to be satisfied by the system. Reality is then expressed in terms of a manipulable language (usually mathematical) and manipulations are carried out according to basic rules to derive, in terms of a meta language, an "optimum"; this optimum is then translated from the meta language into terms of real life and the real life optimum is pursued and checked to see whether the whole analysis is justified.

Some operational research workers regard the subject as a collection of mathematical or statistical tools, such as queueing theory and linear programming. On the other hand there are those who seek to formulate operational research as a mystique comparable to the mystiques which operational research workers deplore in other specialities and other management functions. Operational research is neither of these two extremes. It is a whole, complete study in which mathematical techniques bear the same relationship to the study as the rules of grammar do to literature.

The most important part of an operational research job is the formulation of the problem and its primary exposition in the meta language. Of equal importance is the final act of translation from the meta language into reality. The actual manipulation methods are of secondary importance only and indeed in many studies this stage is comparatively trivial. It is unfortunate that both the American and the British operational research journals do not make this point clear in the papers presented therein.

The emphasis and interest of the straightforward mathematical and statistical methods vary from year to year. Some time ago linear programming had an exotic aura. All were convinced of its usefulness; if only problems could be found which it would solve. Now, however, it is widely applied to transportation problems and to problems of the allocation of capital resources. The ubiquity of computers, and the ease with which linear programming can be programmed into a standard form on them, has meant that linear programming without tears has become an everyday event. At the same time it is being realized that the use of this tool opens up a field of research in that serious basic restrictions are exposed. The first is an obvious one: linearity. Industrial life is often non-linear. Second is the problem of the imprecision of the parameters put into the basic equations and inequalities. If these parameters are subject to error what is the effect on the solution both in terms of the subject of optimal policy and the distribution of expected pay-off? We may paraphrase Box and term this the "robustness" of the solution.

Queueing has been widely developed as a pure statistical theory, largely separate from industrial needs. Although some industrial queueing situations can be expressed in terms of the standard queueing theory models, many of the distributions have not heard of D. G. Kendall. Other complications arise when an algebraic solution of the queueing model is attempted. At this stage resort is often made to simulation and Monte Carlo methods: these have been greatly developed in recent years and are obviously attractive. One of the virtues of a simulation approach is that it forces the operational research scientist to express with clarity the fundamental patterns of behaviour of the process that he is simulating. At the present time one is probably seeing only the beginnings of the revolution that computers are going to cause in our scientific methodology in general and in mathematical techniques in particular.

Some of the queueing techniques are the models and methodology for inventory control; this is a field in which much work has been done in the derivation of models and methods. It is, however, rare to find an inventory situation which can be solved by classical methods.

By far the most common techniques at present used are ordinary statistical and mathematical methods. Statistically designed experiments are rare (all would use them if circumstances permitted) and difficulty is often caused by the uncontrolled nature of the data. Statistics as a subject was developed to meet the need of agricultural and biological research and it needs now to turn to the problem of processing industries

in particular. Box's development of the evolutionary operation⁵ is one step in the right direction, but operational research needs a lot more help from the statistician than it is getting at present.

Two techniques of interest to the mathematician are game theory and dynamic programming. The main drawback of the game theoretic approach to problems is that the most straightforward theoretical problem—the two-person zero sum game—seems to have no analogy in industry. The gaming situations with which the operational research worker is confronted are far too complicated for the elegant theory to tackle. On the other hand dynamic programming is a tool of great potential and a study of Bellman's book⁶ is commended. The most stimulating aspect of dynamic programming is that it tries to solve the implicit interlocking and mutual dependency of chains of decisions. An alternative approach is currently being made to this problem by Kimball who is developing the theory of Markoff chains.

The manipulation of the mathematical model is still only of secondary importance. Of first importance is the movement into and out of the manipulative language; this is an area in which the skill of the scientist *qua* scientist is paramount. There is a need to develop in teachable form the elements of the diagnosis of an industrial situation. A tendency exists for operational research workers to rush their diagnosis and throw a study into standard queueing, or inventory, or linear programming terms. In some cases not enough effort is put into studying the real life situation and trying to understand it. Equally the relevance of the solution needs to be studied; what may be significant in statistical terms may be nonsense in practical terms. When the facts of life are known the correlation of the birth rate with the immigration of storks becomes nonsense. Equally one needs to know the facts of business or industrial life before proposing theoretical solutions to a practical problem.

5. Organization of Operational Research Groups

The pre-requisite for the success of an operational research group is that its members must have free access to all parts of the industry. As long as this criterion is satisfied and as long as the operational research group is enabled to report direct to all people concerned in the problem being tackled, then the actual location of the group within the parent organization is of secondary importance. One of the problems with which management is faced when setting up an operational research group is that of

establishing its relationship with other specialities. The operational research worker is always quite sure where he ought to be in an organization, namely, reporting to the board of directors. Unfortunately, this claim is also made by the other management specialists. Consequently the reaction of top management is to place its operational research group somewhere in one of its functional departments. The particular department in which the group is located is largely dictated by personalities, but a fairly common location is in one of the functional departments devoted to production or production control. While this does not affect the quality of the work in this particular area it does mean that the group can be inhibited from carrying out studies in other aspects of their firm's concern and it may completely block them from studying top-level strategic problems which occur as a result of inter-departmental conflict. However, location in a production department is probably far better than location in a finance department; some operational research workers find it difficult to get a common language with which to discuss their problems with accountants. Until, as mentioned above, operational research workers and accountants learn a bit more of each other's specialities this language barrier, and possibly also a philosophical barrier, will mean that an operational research group located in a finance department is not likely to flourish.

The most successful location for operational research workers has proved to be either in departments which have no direct functional responsibility or else as an independent entity reporting direct to the top management. This top management can have a direct functional responsibility in the organization, but so long as he is part of a community of top managers who are encouraged to take a broad view of their industry's activity, the operational research worker will be able to survey the whole field of his firm.

Certain exceptions to this generalization can be made in the light of experience to date. The first is that to locate an operational research group within the scientific research department of a company may be to place it under a grave handicap from the beginning. Although the operational research worker is primarily a scientist, the field of problems which he studies is different from those tackled by research men, the time scale will also be different, and the ease of access to the industry itself may be difficult from the pure research side. An operational research group so located may never succeed.

The most important factor in deciding the location of an operational research group in a firm is to enable it to have close relations with other

management specialities without destroying its distinctive quality. Some organizations have put operational research in the O and M department or inside the work-study department. Such a location is likely to prove inimical to its success in exactly the same way that O and M and work study might also be doomed to failure if they were located within an operational research group. The proper place for the specialists is to exist as separate entities, but this does not mean that there should be no intercourse between them. Indeed in many organizations communication between these specialist functions has been more frank and more useful when they have been kept apart in this way than when one speciality has been organized within another.

One attractive solution to the problem is to have various management specialities on equal terms within a management science department; this would provide the cross fertilization which is necessary and would also enable changes of staff between various specialist techniques to be undertaken so that they may learn something of each other's contributions and methodology. It certainly would make the problem of top management more easy, in that they would not have to resolve the present confusion which often exists in their minds between the proper fields of activity for these various specialities. It is important, however, that the grouping of separate management specialities into a management science department should not cause these separate specialities to lose the stability they at present enjoy by being located within a functional department. Method study for example is often located in the production side and O and M in the finance side; this gives them a sense of belonging. The danger of having a separate management science department is that it might become divorced from the main stream of the industry. One would want to avoid the feeling that those who can manage, do so; and those who cannot manage, do management science.

The Operational Research Society has a responsibility in influencing the relationship of operational research workers with other management specialists. Some method-study engineers and some O and M specialists do not seem clear as to what is operational research, in so far as either its field activity or its techniques are concerned. There should be more joint meetings arranged with other professional bodies. Specialist management services have much to learn from each other; not so that they could do each other's jobs, but rather that the one can where necessary suggest problem areas for the other to tackle. In any event, management will only be confused and antagonized if the facile denigration of each

other's speciality which has become so fashionable in recent years is continued.

6. Education and Training

Many universities and polytechnics have offered courses of one sort or another in operational research. There are four possible audiences for such courses:

- (1) management specialists who want to know what operational research is and how it is done;
- (2) managers and executives who might want to start up operational research;
- (3) scientists who want to know where operational research fits into the general context of the scientific activity;
- (4) operational research workers, actual or potential.

If operational research is a science, then it is teachable and the main concern of this section is to establish the type of course needed for this fourth group. It might be that the circumstances to enable a successful teaching of the subject are difficult to obtain, but this does not mean that the subject itself is difficult to teach.

The first point to establish is that it is not sufficient, indeed it is dangerous, simply to teach a list of mathematical techniques. A knowledge of these techniques is necessary, but it is by no means sufficient. One must clearly start with the potential operational research workers at post-graduate level. At present only Birmingham University offers a post-graduate course in operational research and reference to this has been made in a paper by M. G. Kendall⁷ which reviews education for operational research. The important basis of post-graduate work is that it must be firmly rooted in practical studies. To do otherwise is like trying to teach chemistry while denying the student access to a laboratory. So far as post-graduate degrees in operational research are concerned one of the best courses is probably that organized at the Case Institute of Technology in the U.S.A. The course for the master's degree takes 2 years' full time study and includes examinations in mathematics and statistics, practical project work for industry, a thesis on a special study and courses of lectures on the scientific method and the specialist techniques of operational research. The Ph.D. course builds on from the M.Sc. course with further work at an advanced level. The great advantage of the post-graduate work is that it is all founded on practical studies

carried out within industry and that the lecturing staff have all had extensive practical operational research experience.

How can this be adapted for use in this country? The prime responsibility rests firmly with industry and courses such as those outlined need money to start them and, more particularly, need experienced staff to act as tutors. Industrial operational research groups should be willing to lend senior staff to universities to help teach operational research and to assist in the research programmes. The selection of these people is a matter of great importance as teaching is a highly skilled profession and the good operational research worker is not necessarily a good lecturer. It will also be necessary for universities to allow their operational research staff and students to do consulting work for industry.

So far as the syllabuses for courses for the first three types of audience listed above are concerned, there is a great variety of content. Some of the courses offered have been quite disturbing. For example, one education institute offered a 2-week "Appreciation Course in Operational Research" which was simply work study, probability theory and linear programming. Fortunately, in the past year the Education Committee of the Operational Research Society has made known its eagerness to help in running operational research courses and one hopes that ultimately standards will be raised. In the meantime, however, some damage has undoubtedly been done to the subject by courses which have been put on by people who have no contact with operational research.

Education in operational research will really have arrived when we have a few chairs founded at our universities; this would ensure the carrying out of the fundamental research which is necessary and would place the teaching of the subject on a firm basis. This will probably only come as a result of the industrial investment in operational research being extended beyond the money necessary to run the industrial operational research groups themselves and on to the founding of university departments.

7. Management Consultancy

One of the major differences between operational research in the United States and in Britain is that whereas in this country the industrial operational research effort is concentrated in a number of large firms, in the United States it extends also on the one side to universities and institutes of technology, and on the other side to management consultants. These consultants include a number of firms of accountants who are taking up

operational research in a responsible and enterprising manner. We in this country are now seeing the initial development of operational research within some of our larger management consultancy firms. Although there are one or two cases where smaller consultant firms are offering operational research to industry merely as a new label to put on their old wares, the major management consultants are in general going into this slowly and cautiously and are appointing experienced operational research men to open up this new field. This stage is one of the most encouraging in recent years. There are also, of course, two or three experienced operational research men successfully working as independent consultants. It is necessary for the development of our subject that these consultant activities should meet with success. We have got to be able to demonstrate to management that investing money in an operational research project is one of the most profitable activities at its disposal.

8. Careers for Operational Research Workers

During the last few years there has been a boom in operational research. It has hardly been possible to look at a newspaper without seeing operational research jobs advertised. In recent months, however, there have been signs that the boom is coming to an end and that, apart from consultants, there are few fresh jobs being created for operational research men. It will indeed be useful if for a few years operational research can consolidate and the groups established in industry learn about their industries and move on eventually to do strategic studies. There will ultimately be a further expansion of operational research but at the present time many operational research workers are facing the question "what is my ultimate career in this subject?" Operational research depends on an intake of lively intelligent young people. These people are naturally ambitious, in fact if they were not so they would not be of the type for operational research.

Some lip service is paid to the idea that operational research is a training for management. The operational research worker is not *per se* a potential manager. The experience which he collects is obviously the raw material for management experience, but this is not the same as saying he is a manager. However, if an operational research worker is likely management material he will have received first-class training and first-class experience by working in the operational research group. So far very few operational research workers have made the transfer into senior management positions.

Many operational research men, working as they do for top management, wish that they were the top management. It remains to be seen how far this ambition is likely to be achieved. Operational research provides a good career to the £3,000 a year level, but the man who wants to go beyond this is likely to have to do a great deal of thinking to see how far he can translate his operational research experience into something of use in his firm in some other field. Unfortunately, operational research workers are in such demand that some managements are loath to move an experienced man out of his present job into something which will enable him to develop and get more experience, because of the difficulty of replacing the man himself in his present job. During the next few years the careers of senior operational research workers will be watched very critically by the juniors with these points in mind.

9. Conclusions

It is as well at this stage to repeat that this paper is a personal view of operational research and does not necessarily represent the opinion of anyone other than the author. With this in mind the following general points are presented as a summing up of the present position of industrial operational research in Great Britain.

(1) During the war startling successes were achieved by military operational research. This was probably mainly due to the use and acceptance of the subject at the highest strategic and tactical levels. There is, *prima facie*, no reason to doubt that similar successes could be achieved by the strategic use of operational research within industry today. In fact, such work and such successes have already been accomplished. However, most of our work is still in fields which have been the subject of continuing study at the tactical/operational level for many years prior to our arrival on the scene. In such cases management obtains a high level of skill in the operations and it is unlikely that cost reductions or productivity increases of more than 5 per cent to 10 per cent will be obtained by the operational research men. Such proportions may well be highly desirable in absolute terms.

The operational research worker, however, must be patient in understanding the industry in which he works, must not be disappointed that a number of the projects posed him are intractable and, most important of all, he must resist the impulse to over-sell his speciality.

(2) The best way of communicating operational research studies both to operational research scientists and to management is by means of the

operational research journals. Operational research workers need to publish far more than they do at present and so ensure that their work is subjected to lively informed criticism from other scientists. At present the literature not only gives a misleading account of industrial operational research but this research itself is out of balance.

The fields of marketing, purchasing and human problems still await exploration by operational research workers, and until this has been done operational research will be largely inhibited from moving into the field of strategic studies. In this latter field lies the greatest potential of operational research.

(3) Operational research groups and their parent industries have a responsibility to their intake of young scientists; this responsibility extends beyond that of providing an adequate career within an operational research group to that of ensuring that wider experience in the parent concern is provided for those who are likely to benefit from such experience.

(4) The mathematical and statistical techniques need to be developed in the areas of linear programming, queueing theory and inventory control as well as in the broader field of the problems arising from uncontrolled data. There is a need for developing techniques of diagnosis and for assessing the relevancy of theoretical solutions.

(5) There is a need to review the relationship of operational research with other management aids, such as method/work study, organization and methods, accountancy and market research. This needs to be carried out both on the professional level by the appropriate societies and institutions and also by industrial firms which have these aids in their organization hierarchy. One attractive solution to this latter problem is to group some of the aids in a management science department, although certain safeguards would have to be met.

(6) A science will only progress if it has competent scientists working in its speciality. This applies with particular force to operational research and there needs to be an expansion and improvement of educational facilities in the subject. This is particularly needed in the field of post-graduate courses.

(7) A final cautionary note. There is a danger of operational research workers getting too self-conscious and being fascinated by constant reviews of the progress of their subject. While this paper is appropriate to the needs of the Harrogate Conference this year, the author suggests that for the next few years an embargo be placed on further reviews of the subject.

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